Effect of number and distribution of mini-implants on the stresses induced on tooth- Supported mandibular overdenture (Strain gauge analysis)

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وَقُلِ اعْمَلُواْ فَسَيَرَى اللّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ وَسَتُرَدُّونَ إِلَى عَالِمِ الْغَيْبِ وَالشَّهَادَةِ فَيُنَبِّئُكُم بِمَا كُنتُمْ تَعْمَلُون

صدق اللة العظيم

التوبة(105)

INTRODUCTION

Rehabilitation of a partially edentulous patient can be established using a wide range of prosthetic treatment options depending upon the clinical need and demand .Restoration of the lost structure can be achieved by using a simple conventional removable partial denture, overdenture, fixed partial denture, or prosthesis constructed on dental implant .Choice of a single or a combination of these will completely depend upon number and status of the existing teeth, available bone and influenced by the esthetic and functional demands of the patient, the best alternative to the replacement of natural teeth is the dental implant, which simulates the root structure of natural teeth .

The retention of few remaining teeth which will be used as overdenture abutments combined with implant to share in retention and stability is an ideal line of treatment, the number of teeth and their distribution in the dental arch will defiantly affect load transfer and the ability to support the overdenture.

Bilateral abutments symmetrically located in the dental arch should be used as it offers the most satisfactory support for the denture. Canines are frequently among the last teeth to be lost and their large root surface makes them particularly suitable for use as overdenture abutments. Molars also offer substantial support for overdentures, however optimal abutment distribution for one arch typified by 2 cuspid and 2 second molars, this rectangular distribution provides maximum stability and support for the restoration. (1)

Since the late 1960s, when dental implants were introduced for rehabilitation of the fully edentulous patient, an awareness and subsequent demand for this type of therapy has been increasing. (2)

However the diameter of standard implants (approximately more than 3.5) along with the frequent need to graft bone to allow for their placement have limited their use for those who need implants. The introduction, approval and continuing observation of success of smaller-diameter implants have stimulated use of implants in situations in which standard-sized implants could not have been used without grafting. (3)

The narrow design of mini dental implants and the simplicity of the techniques required make it the cornerstone for building clinicians confidence and for providing a transitional route to a more advanced comprehensive implant dentistry. [4]

The number of implants and the implant position within the prosthesis affect the forces acting on the bone adjacent to implants, Also implant diameter, shape, and load direction influence stress distribution.

Proper selection of the number and the most favorable location of dental implants in relation to natural teeth existing will definitely affect the amount of load transferred to a lower overdenture supporting structures.

Overdenture

Preventive prosthodontics emphasizes the importance of any procedure that can delay or eliminate future prosthodontic problems. Retention of the roots of one or more teeth for overdenture offers the patient a lot of advantages like better stability, proprioception, support and retention. [5]

Overdentures are prostheses which are fabricated over the existing teeth or roots or implants, the retained teeth/roots or implants which are more commonly used nowadays help in preserving the alveolar ridge. Healthy periodontal ligament around the teeth maintains the morphology of the alveolar ridge. [6]

The concept of overdentures was presented at the World Dental Congress in 1861 by Butler, Roberts and Hays who presented history of 12 years treatment results. This treatment was not accepted worldwide that time and its renaissance came in the sixties of twenties century when new clinical procedures in the field of periodontology and endodontics were used. These procedures significantly prolonged the lifetime of the remaining teeth. In comparison with the complete denture the main advantage of overdenture is preservation of the alveolar bone which resorbs as a consequence of the teeth loss. [7]

According to Zarb et al[6] , the advantages of overdenture include maintenance of residual ridge integrity, due to the presumed improved occlusal stress distribution, enhanced denture retention and stability especially the mandibular overdenture, preservation of proprioception resulting in better occlusal awareness, biting forces and consequent neuromuscular control, overdenture fabrication technique is viable and simple alternative to complete denture therapy, applications of overdenture is unlimited and it depends on the dentists judgment and skill, and above all, on the patient's motivation to maintain impeccable oral environment.

The key factor to this procedure is the effective endodontics. This allowed for a shortened dental crown, which created adequate space for the overlying artificial denture tooth and denture base. Moreover the shortened crown also changes the crown to root ratio thus reduced mobility of the root and improves the bone support. The second

important factor is the better retention of the denture when leaving any root. At the same time there is significantly lower rate of bone resorption, so the remained tooth prevent rapid bone loss [7]

Disadvantages of the overdenture treatment include the need for inevitable treatment, which requires additional time and increases costs. [8] The construction of an overdenture is costlier due to the endodontic therapy required and the subsequent restoration of their teeth with alloys or gold copings, the bony undercuts also due to the retained teeth, there are limited paths of insertion. This will lead to the blocking out of undercuts resulting in denture flange spaced away from the tissue, creating a food trap. Sometimes because of the undercuts, the denture will be overcontoured resulting in excessive fullness of the lips. Also the denture flanges will be undercontoured for it to fall into place. Therefore proper patient selection is required, and finally an overcontoured flange which disturbs the natural fullness of lip can cause compromised esthetics, this overcontoured flange would be the result of blocking out of anterior undercuts which would interfere with the placement of the denture. If the problem is severe enough it may contraindicate an overdenture. [9, 10, 11]

The rate of success of overdenture supported by 2 implants was studied by Jem et al. concluded that the mean marginal loss was 0.5 mm during a 5-year period [12].

Treatment considerations for implant overdentures on the maxilla appear to be different from those on the mandible. The atrophy of the edentulous jaws may limit implants placement in the maxilla, whereas in the mandible, the reduction of alveolar ridge often leaves a significant depth and width of basal bone anteriorly to accommodate implants. The maxilla consists of a looser arrangement of trabecular bone which is less capable of stabilizing and supporting implants. [13]

Further, the extraction of the last remaining teeth and the replacement with complete dentures has many consequences. The patient has to adapt to a new situation with a respect to teeth, chewing, swallowing etc. The patient has to accept being edentulous which may lead to psychological problems and social isolation. [14]

According to a study by Crum and Rooney [15] when mandibular canines were used as overdenture abutments, the resorption of alveolar bone around these teeth reduced by 8 times.

According to Jerge [16], the periodontal receptors present in the abutment teeth actively influence the cyclic joint movements of mastication by influencing the muscles of mastication by their proprioceptive feedback mechanism.

Types of overdentures according to support :

Overdentures can be classified according to the abutment type into two broad classifications [17]

I- Tooth-supported- overdentures.

II- Implant-supported –overdentures

I-Tooth-supported overdenture:

Tooth-supported overdentures require four abutments that are widely distributed in the arch. Two canines and two second premolars represent the ideal distribution of masticatory forces, thus providing the maximum stability and support for overdenture, [18]

According to Robert L Defranco [19] tooth supported Overdenture accomplishes three important goals, It maintains the abutment teeth as part of the residual ridge, which in turn provides more support than a conventional complete denture also When the teeth are retained, the alveolar bone integrity is maintained as it supports the abutment teeth, therefore there is decrease in the rate of resorption of alveolar bone. However when teeth are removed then the alveolar bone resorption process begins and With the preservation of the teeth, there is also the preservation of the periodontal membrane and this in turn preserves the proprioceptive impulses, When the patient wears the denture he will have the sensitive ability to be aware of occlusal contacts, the patient thus also will be able to control the forces of Occlusion as he used to with his natural teeth.

Carlson GE [20] concluded in his review article of bone resorption, that the best way to prevent bone resorption of the alveolar ridge is by avoiding total extraction, preserving a

few selected teeth and fabrication of abutments over the teeth. He also concluded that supported prosthesis will lead to less bone loss and may even promote bone growth.

Tooth-supported- overdenture is sub-grouped according to:

- Period of construction.
- Mode of support.
- Oral condition.
- Stability.

A. ***Period of construction***:

- **Immediate overdenture:**

An immediate overdenture is constructed for immediate replacement of hopeless teeth in order to increase support, stability, and preserve of the residual ridge. Its technique is relatively simple, having clinical and laboratory procedures similar to those of immediate complete dentures, except for selection, and preparation of the abutment teeth. (21)

Comparing bone reduction under complete immediate overdenture and complete immediate denture showed that the use of immediate overdenture produced bone reduction half than that of conventional complete denture. (22)

- **Transitional or interim overdenture:-**

A transitional overdenturre is obtained by converting an existing removable partial denture to an overdenture through addition of artificial teeth to replace hopeless natural teeth. It helps in maintaining the patients vertical relations, prevents overclosure and excessive occlusal forces from being applied to the abutments. (18)

- **Remote overdenture:**

A remote overdenture is constructed for placement at sometime remote, usually a year or more after the removal of the last hopeless teeth. It may be used for patients with only few remaining teeth, all of which will be abutments. Most

patients are given immediate or transitional overdentures prior to receiving a remote overdenture. [23]

B- Mode of support:

- **Tooth-supported overdenture:**

Tooth –supported overdenture requires four abutments that are widely distributed in the arch. Two canines and two second molars represent the ideal distribution of masticatory forces, thus providind the maximum stability and support for overdenture. [18, 24]

- **Mucosa-tooth-supported overdenture*:***

In mucosa- tooth supported overdenture, the abutments are located in the anterior region of the dental arch. The distribution of three abutments in the arch consists of two canines and central incisor provides a tripod of support in the anterior jaw. This type is particularly effective for a maximllary overdenture opposed by mandibular natural teeth. However, the most frequent distribution pattern is two abutment teeth usually the canines but also they could be premolars. [24]

C- Oral condition:

- **Completely edentulous patients**

It is a complete overdenture constructed over remaining natural teeth. Such teeth may be hopeless for routine restorative procedures but could serve as excellent abutment for an overdenture. However complete overdentures are superior alternative to complete dentures supported only by alveolar tissues. [25, 26]

- **Partially edentulous patients**

A new classification was advocated for partial removable overdentures (PROD), combining Kennedy's system and the American Dental

nomenclature system offer familiarity. PRODs are still Kennedy classed as if no overdenture abutment roots were present, then the designated overdenture (od) is added, followed by the tooth numbers of abutment roots.[27] When the abutments are strategically located they will provide stress distribution on remaining teeth and residual ridge and can minimize or eliminate the movement of removable partial denture.[28]

- **Congenital and acquired defect patients*:***

  Congenital defects that are most frequently treated with overdentures are associated with cleft palate, oligodontia, microdontia cleido- cranial dysostosis and class III patients. The acquired defects result from accident or disease can be treated satisfactory with overdentures. [27, 29]

- **Irradiated patients:**

  Restoration of irradiated patients includes the avoidance of extraction, simplicity of the treatment and home care follow up. Overdenture fulfilled theses goals while maintaining high levels of function and esthetics. [30]

D- Stability:

Overdentures were classified into one- plane stability overdenture supported by two canines. Adding a posterior abutment to the one- plane stability provides a two- plane stability overdenture. Three- plane stability overdenture on the other hand with the best distribution of forces of mastication can be provided with anteriorly and posteriorly distributed abutments. Three- plane stability overdenture is preferred as it provides a great degree of support, stability and retention. [25]

II-Implant-supported overdentures:

During the same time period that techniques for producing tooth-supported overdentures were being perfected, P. I. Brånemark was developing the science

osseointegration. Once established that osseointegration is a predictably successful treatment, it was a natural progression to the notion of using osseointegrated implants to bear overdentures. . [31]

Root-supported or implant-supported overdentures can help to solve the problems created by a partially or completely edentulous maxilla or mandible. Root-supported overdentures are an alternative to extractions and complete dentures. The overdenture will increase the patient's retention, stability, and resistance to denture displacement. Retaining the existing teeth also will preserve the alveolar ridge, prevent bone loss, and increase masticatory performance. [32, 33]

Implant-supported overdentures have been used for the treatment of completely edentulous cases because of their advantages and enhanced properties on the treatment outcome, the advantages include prosthesis fit, function, stability, phonetics and speech. [34 35]

In the 1980's the standard protocol described by Schroeder [36] and others [37, 38] were the placement of four implants. Later in 1985, it was suggested that only 2 or 3 implants were adequate for overdenture support [39, 40]. Nowadays the overdenture usually comprises of two or more implants which are usually placed bilaterally on an arch. It has been suggested that there is
increased biting force after implant treatments [41, 42] and a patient wearing an implant supported overdenture has better psychological effects due to the improvement in retention and function of the denture. Few authors have also recorded that peoples social life have become more active, after converting to a implant supported overdenture from a conventional overdenture [43, 44, 45]

Studies conducted by Locker D [46] and Feine JS et al [47] also show that patient's perceptions of functions related to mastication improves with the use of implant supported overdentures The placement of dental implants and the insertion of implant

supported prosthesis in edentulous mandibles have shown to substantially reduce the alveolar bone loss in comparison to that of patients wearing conventional complete denture. [48, 49]

Implant- supported overdentures can be classified according to support into:

I-Entirely--implant-supported overdentures:

The entirely implant-supported prosthesis utilizes in most cases four or more implants to provide total support for the prosthesis. The mucosa does not contribute to any load sharing. A distally extended cantilever bar had also been advocated to maximize the retention of the distal component. However, this could be associated with increased loads on the implants during mastication [50] The magnitude of load depended upon the number of implants, the quality of bone at the implant site, the length of the cantilever and the antero-posterior spread which is defined as the distance from the center of the most anterior implant to a line joining the distal aspects of the most distal implants. [50, 51]

II.Combined- mucosa-implant-supported overdentures:

The implant-mucosa-supported prosthesis depends on the idea sharing load between the implants and the mucosa of the distal extension. In most cases it utilizes fewer number of implants usually two interforaminal implants. [50] The load sharing is obtained by allowing the prosthesis movement under functional load. This movement is allowed by the resiliency of the attachment used. [52]

Assad et al [53] classified overdentures according to support into mainly-mucosa-supported, implant-mucosa-supported and implant-supported overdentures. They used the term mainly mucosa-supported to describe overdentures retained by stud or magnetic

attachments and the term implant-mucosa-supported to describe overdentures retained by a resilient bar attachment.

III-Mucosa- implant-supported -overdenture:

It is attached to two implants by means of resilient stud attachments or magnets, allowing rotation and translation of the overdentures. This overdenture is almost totally supported by the mucosa .it is indicated for patients with retention problems. [54, 55]

Overdenture abutments

Proper selection, design and preparation of abutment teeth are the main factors to achieve proper stress distribution on the overdenture. Preservation of natural teeth to be used as overdenture abutment is very important as it considered as the best implant ever invented. [56]

Abutment teeth prepared so that sufficient tooth structure is removed to improved clinical crown root ratios and to allow sufficient space for an esthetic artificial tooth of proper size and contour over the abutment coping. [57]

Whenever possible bilateral abutment symmetrically located in the dental arch should be used, this arrangement will offer the most satisfactory support for the denture and will minimize the possibility of fatigue fracture of the base or excessive loading of the abutments. [58]

Preparation should taper toward the incisal or occlusal surface permitting development of coping contour which taper similarly and terminate in a rounded occlusal surface [61]. This contour result in a ball and socket type contact between the tooth coping and the denture base, and chamfer-type margins should extend beneath the gingival margin and should be definite enough to permit accurate carving of the wax pattern [57]. The length of these copings various from short 2-3 mm in height to long 5-8 mm. A short dome -copings seem ideal to many investigators [59, 60]. They offer favorable crown -root ratio, allow the transmission of occlusal load along the long axes of abutment and help in